

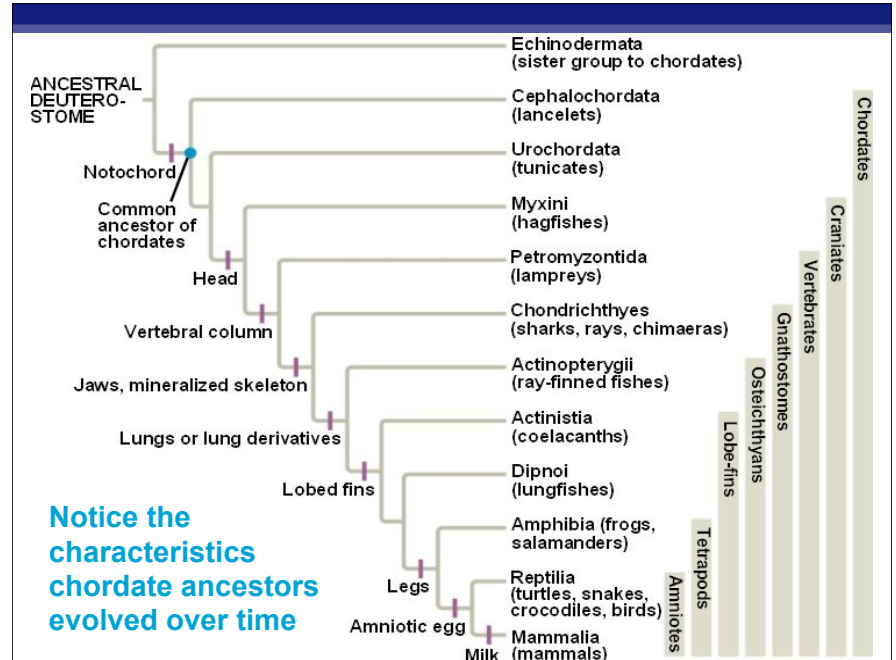
Phylum Chordata

Chordates

- ◆ Multicellular
- ◆ Bilaterally symmetrical triploblasts
- ◆ Coelomates with full-fluid filled gut tube
- ◆ Deuterostomes
- ◆ Organ system level of organization
- ◆ Cephalized - *has a head*
- ◆ Endoskeleton of cartilage and/or bone and a few with an exoskeleton.
- ◆ Fully-lined thoracic and abdominal cavity - *lined by epithelial cells*
- ◆ In early stages of development, all chordates have a subpharyngeal gland for concentrating iodine.
 - This gland is homologous to the thyroid gland in humans.



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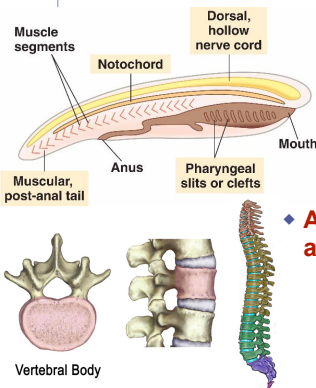


Phylum Chordata

Four key Characteristics set chordates apart

1. Notochord

- A longitudinal flexible rod located dorsally between the digestive tube and the nerve cord
- Large fluid-filled cells encased in stiff, fibrous tissue: **cartilage**
- A skeletal structure present in **all** chordate embryos and **some** adults
- Provides skeletal support and a flexible structure for **muscles** to work against
- ◆ A complex jointed endoskeleton develops around notochord in **vertebrates**

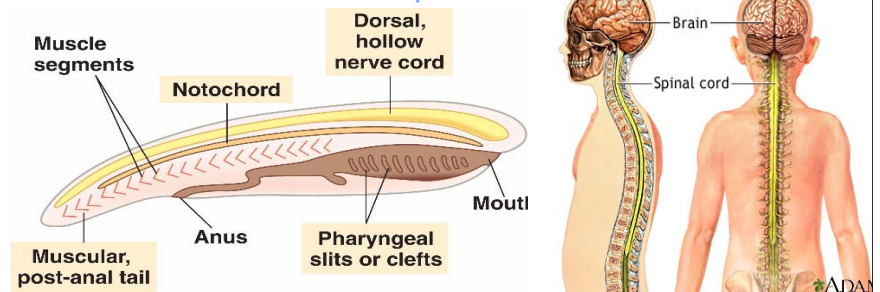


Phylum Chordata

Four key Characteristics set chordates apart

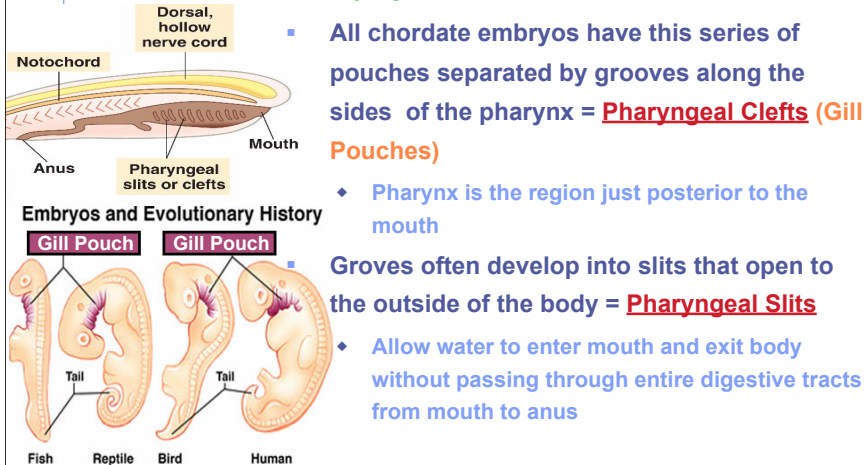
2. Dorsal, hollow Nerve Cord

- Develops from plate of ectoderm
 - ◆ Ectoderm rolls into a tube located dorsal to the notochord
 - Other animals only have **SOLID** nerve cords
 - Often located ventrally not dorsally
- Develops into **central nervous system**:
 - ◆ The brain and the spinal cord



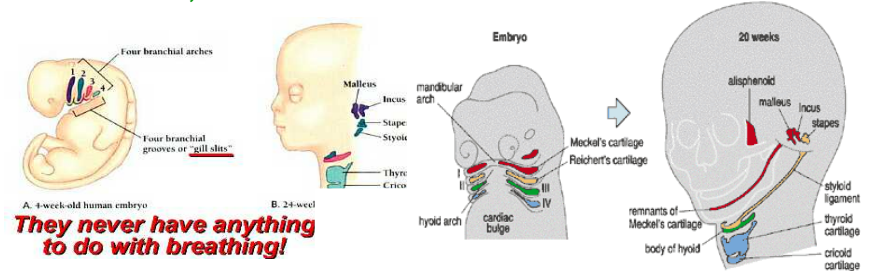
Phylum Chordata

Four key Characteristics set chordates apart 3. Pharyngeal Slits or Clefts



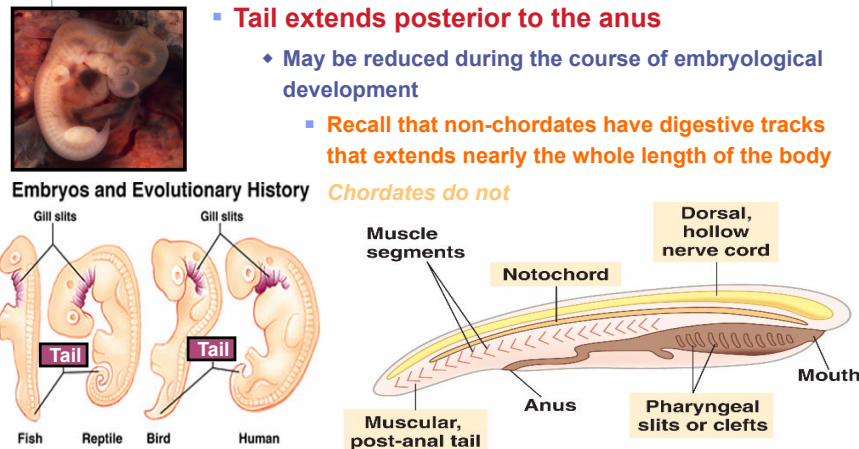
Phylum Chordata

- Invertebrate chordates**
 - Slits become suspension feeding devices
- Vertebrates without limbs**
 - Slits become gill slits of gills (fish)
- Tetrapods (like humans)**
 - Clefts do not become slits and develop into parts of the ear, head and neck



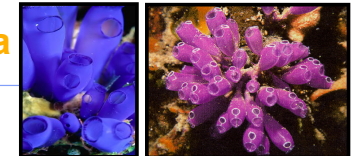
Phylum Chordata

Four key Characteristics set chordates apart 4. Muscular Post-Anal Tail



Three subphyla of Chordata

- Subphylum Urochordata - The Tunicates**
 - Larval stage possesses all of the chordate characteristics
 - Most of these characteristics are lost when the larvae undergo metamorphosis and emerge as adults
 - Adult stage are primarily sessile marine filter-feeders
- Subphylum Cephalochordata - The Lancelets**
 - Possesses all of the chordate characteristics throughout life cycle
 - dorsal nerve cord
 - Notochord
 - gill slits
 - Burrow into sand and use mucous-secreting organs to filter-feed
 - Feeble swimmers
- Subphylum Vertebrata - The vertebrates**



The Craniates

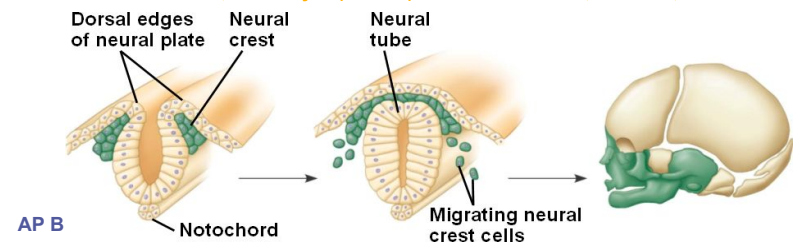
- **Craniates (Cranium = skull)** are chordates that have evolved a head!
 - ◆ The head consists of a brain at the anterior end of the dorsal nerve cord, eyes and other sensory organs, and a skull
- **Enabled chordates to:**
 1. Coordinate more complex movements
 2. Have more complex feeding behavior
- **Class Agnatha - the jawless fish**
 - ◆ **Examples: lamprey, hagfish**
 - no jaws
 - most are parasitic fish
 - very diverse group in past
 - Today, only a few species are still hanging on



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The Craniates

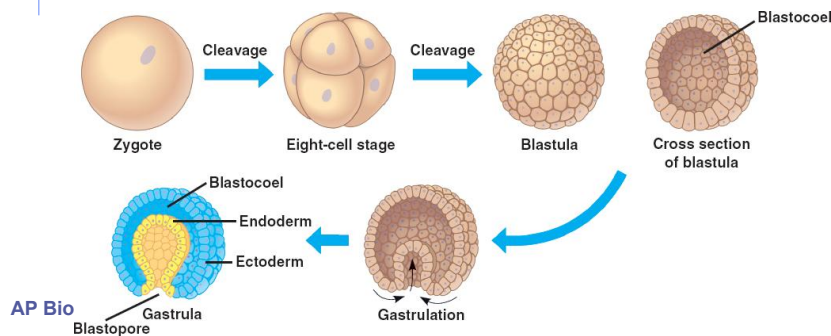
- **Craniates unlike other chordates possess two clusters *Hox* genes (duplication of genes)**
 - ◆ This adds additional genetic complexity so craniates could develop more complex morphologies
 - Lancelets and tunicates have only one copy
- **Unique features of craniate development = Neural Crest**
 - ◆ Collection of cells that appears near the dorsal margins of the closing neural tube in an embryo
 - These cells migrate in embryo and become teeth, bones and cartilage of skull, inner layer (dermis) of skin of the face, neurons, etc..



AP B

Craniate Gastrulation leads to Organogenesis

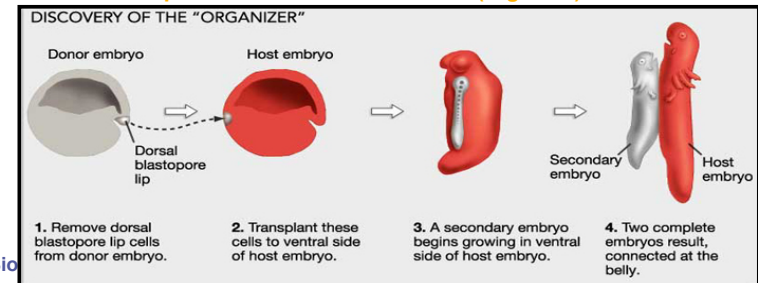
- Recall that after cleavage, during gastrulation three germ layers form in coelomates
 - ◆ **Gastrulation:** Period of cell migrations around blastopore (an organizing center) which converts embryo from hollow ball of cells into a 3-layered stage called gastrula
 - **Germ layers:** Endoderm, mesoderm, ectoderm



AP Bio

Craniate Gastrulation leads to Organogenesis

- **Organogenesis: Organ Formation**
 - ◆ Involves more localized shape changes in tissues and individuals cells
 - First evidence of organ building is the appearance of tissue folds and splits and dense clustering of cells
 - ◆ In chordates notochord develops first then neural tube which will become the Central Nervous System (brain and spinal cord)
 - Occurs via organizing centers
 - ◆ Groups of cells that control fate of (organize) other cells

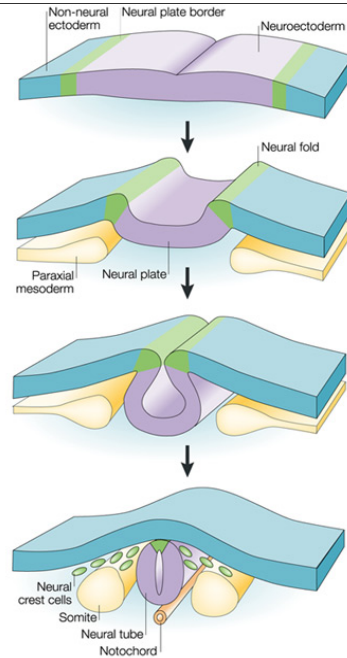


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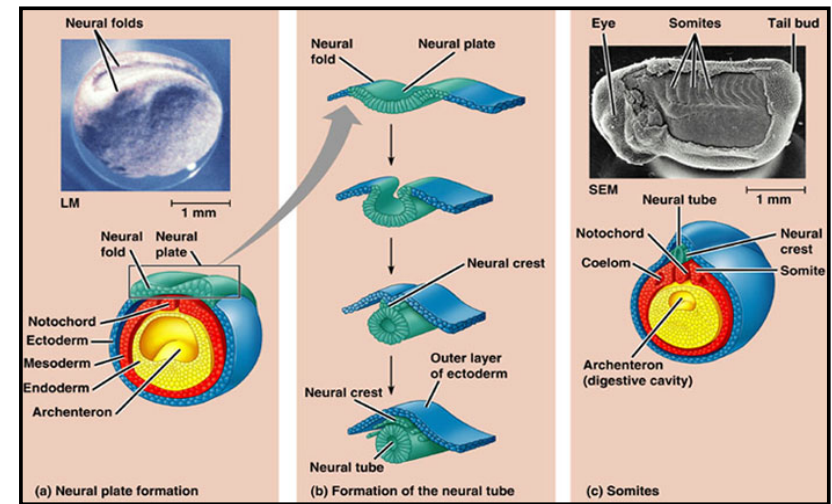
Example of Organogenesis: Neurulation

Neurulation: formation of nervous system via neural tube formation

- Neural plate (forms from ectoderm) is a flat tissue surface that migrates to form tubes
 - Neural tube = Forms from neural plate and becomes the Central Nervous System (brain & spinal cord)
 - Notochord forms from the mesoderm and forms cartilage-like backbone
 - Condensations of cells of the mesoderm next to notochord separate into blocks called somites
 - Somites develop into segmental structures such as vertebrae



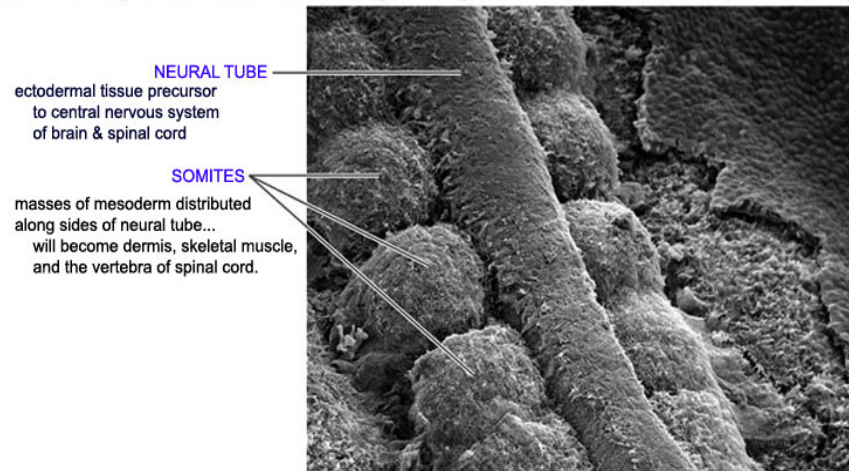
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Example of Organogenesis: Neurulation

SOMITES: segmented mesodermal tissue aligned along the neural tube from anterior to posterior embryo



Phylum Chordata

Subphylum Vertebrata

- The Vertebrates

- Deuterostomes
- Craniates (possessing a skull) with a segmented BACKBONE or SPINAL COLUMN.
 - Have a dorsal (along the back) set of nerves encased in bones that replaces the notochord
 - Have a distinct, differentiated head
 - 50,000 species including amphibians, fishes, reptiles, birds, & humans

Vertebral column - a winning evolutionary design

- Result: Fastest runners, highest fliers, deepest divers, most agile climbers, and the best AP Biology students that ever lived ;)



AP Biology



Phylum Chordata, Subphylum Vertebrata



Oh, look...
your first
baby picture!



becomes gills or
Eustachian tube

pharyngeal
pouches

becomes tail
or tailbone

postanal
tail

hollow dorsal
nerve cord

becomes brain
& spinal cord

becomes
vertebral
disks

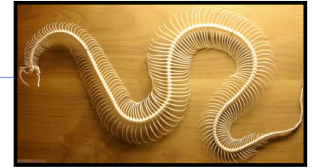
notochord

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Phylum Chordata, Subphylum Vertebrata

Vertebrates like chordate:

- ◆ Dorsal cartilaginous **Notochord** present at some point in development
- ◆ **Pharyngeal Cleft or Slits** present during development
- ◆ Dorsal **hollow Nerve Cord**
- ◆ **Post-anal Tail**
 - **Primitively muscular and used for locomotion**
- ◆ **Subpharyngeal gland** to concentrate iodine
 - **Thyroid gland (in Vertebrates)**

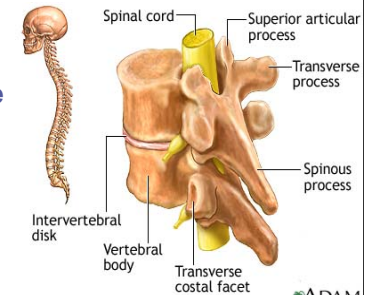


Vertebrate also have...

- ◆ **Extensive skull and a backbone**
 - **Vertebrae encased spinal cord**
 - ◆ Has taken over the **mechanical roles of the notochord**
 - In humans notochord left overs are the **vertebral disks** that are sandwiched in between the **vertebrae**
- **Skull encased brain - protects**



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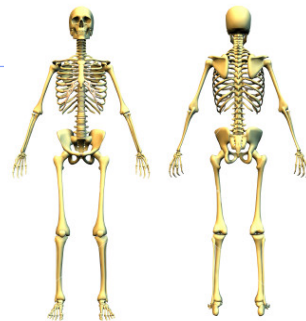


ADAM

Phylum Chordata, Subphylum Vertebrata

Vertebrate also have...

- ◆ **More complex nervous systems & internal skeletal systems**
 - **Increased efficiency of two tasks:**
 1. **Capturing food**
 2. **Avoiding predators/being eaten**
- ◆ **Jointed appendages**
- ◆ **Immune & lymphatic systems for defense**
- ◆ **Endocrine systems** for coordinating body activities
- ◆ **Extracellular digestion** in a complete digestive tract
- ◆ **Closed** circulatory system
- ◆ **Excretion and osmoregulation** through paired kidneys
- ◆ **Respiration** through skin, gills or lungs
- ◆ **Sexual reproduction** and the organisms are **dioecious**



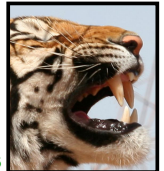
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Vertebrates: Gnathostomes

Jawed vertebrates

- ◆ Includes **sharks, ray-fin fish, lobe-fin fish, amphibians, reptiles (including birds) and mammals**
 - **Jaw** (with teeth) is a hinged structure that enable organism to **grip food firmly and slice them**
- ◆ See another duplication of **Hox genes** resulting in **4 Hox genes**
 - Allowed for further complexity of development in **gnathostome embryos**
 - ◆ **Forebrain is enlarged**
 - ◆ **Enhanced sense of smell and vision**



Class Chondrichthyes

- ◆ **The cartilaginous fish**
 - **Examples: sharks, rays, skates**
 - ◆ Endoskeleton is composed entirely of **cartilage**
 - ◆ **Two--chambered heart**
 - ◆ **numerous rows of teeth**
 - ◆ **internal fertilization and separate sexes**



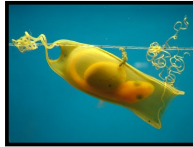
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Development of Young



■ **Ovoviviparous (Most sharks)**

- ◆ Fertilized eggs retained in organ called oviduct - *advantage protects egg from predators outside mother's body*
 - The egg's yolk and fluids secreted by glands in the walls of the oviduct nourishes the embryos.
- ◆ Hatching occurs in the uterus
- ◆ Young are born alive and fully functional



■ **Oviparity**

- ◆ Lay eggs that hatch outside of shark's body
- ◆ Egg case has consistency of leather.

■ **Viviparity**

- ◆ A placental link inside mother to the developing young exists and mother continually nourishes developing young
- ◆ The young are born alive and fully functional

Two documented cases exist in which a female shark who has not been in contact with a male has conceived a pup on her own through a process known as parthenogenesis.